Collection of Particles

Simulated Satellite Measurement Device for Ions, Neutrons, Electrons, …

Time:

50 minutes

Objective:

Through a 'StarLogo' simulation, students will develop an understanding of how solar particles are captured by instruments on orbiting satellites.

Teacher note

This is a simulation where the students can modify some of the parameters, but this is more of a demonstration and should be used in conjunction with lecture and hands on experiments. Advanced students are welcome to investigate the programming in the Starlogo models. They may modify the programs to make the simulation more real.

Content Standards:

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry
  - Identify questions and concepts that guide scientific investigations
  - Design and conduct scientific investigations
  - Use Technology and Mathematics to improve investigations and communications
  - Formulate and revise scientific explanations and models using logic and evidence
- Physical Science – Content Standard B
  - Structure of atoms
  - Structure and properties of matter
  - Motions and forces
  - Interactions of energy and matter

Equipment, Materials and Tools:

- Computer – Mac or PC with Starlogo program from http://education.mit.edu/starlogo/
- StarLogo code file (neutroncollector1.slogo) located in the Appendix section

Background Information:

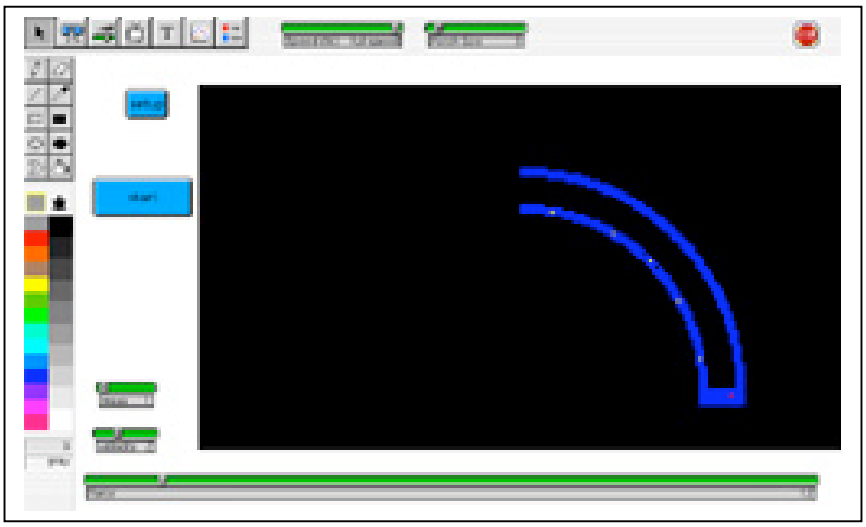
The plasma of the solar wind is comprised of ions. The temperature assigned to this plasma is a measure of how fast these particles are traveling. Since they are physically so far apart in interstellar space, they seldom collide with anything and thus remain charged. The particles are still classified plasma while the conditions in which they were created; high speed and density, no longer exist. Because they are charged particles, they both create and follow magnetic field lines in their travels and are affected by other magnetic fields. The sophisticated and complex measuring devices on-board deep space satellites are based on relatively simple electro-dynamics. The moving charges are pushed by magnetic fields in a direction perpendicular to their motion. The amount of force they feel (how much they are pushed) depends on how long they are in a field (determined by their speed) and how much mass they have (what ion they are).

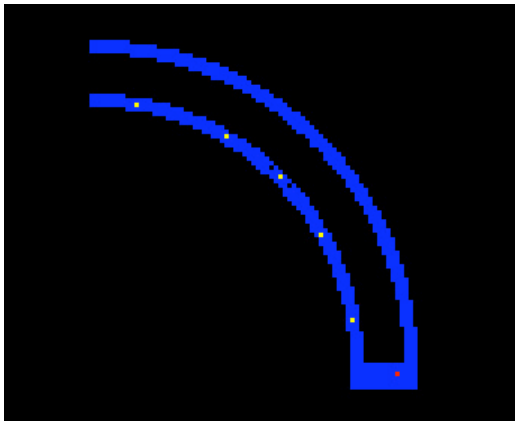
Instructions:

1. Download and install StarLogo software from http://education.mit.edu/starlogo/ on your computer.

2. Start StarLogo. Select File, Open Project and select “neutroncollector1.slogo” (you must copy the program code from the Appendix and save as “neutroncollector1.slogo.” From “Windows”, Select Tool, select “Interface.” You should see the following screen:

The Starlogo model allows the student to vary the force on the field in the measuring device to ensure a certain particle (specific mass and specific speed) makes it to the end of the curved device where it is then detected. By changing the strength of this field, the experimenter sees how too much field force causes a particle to curve too much and vice versa.





The red dot at the base of the curved tube represents a particle that has been collected on the magnetic plate. For a given mass and velocity, the correct force must be found.

This activity simulates the collection device that measures count of neutrons. A semicircular (or some arc of a circle) chamber modifies or bends the trajectory of incoming particles with a electric charge. The model simulates particle velocity, particle mass (1 = hydrogen, 2 = helium, ect...) and electric charge on the semicircular plates. Given particle velocity and mass the student adjusts the electric charge (i.e. force) in order to attract the incoming particle to the base of the collector.